SHORTER ARTICLES AND DISCUSSION

THE PROBABILITY ESTABLISHED BY A CULTURE OF GIVEN SIZE THAT A MATING IS CAPABLE OF PRODUCING ONLY DOMINANT INDIVIDUALS

To distinguish individuals heterozygous from those homozygous for a given dominant factor is a matter of mere inspection when the simplex condition is somatically distinct from the duplex condition, as is the case with the mottling factor in the Adzuki Bean.[1] Generally, however, the degree of dominance is such that a breeding test must be resorted to in order to distinguish these two types. A homozygous dominant will breed true for the character whether selfed or back-crossed to the recessive, whereas a heterozygous individual will give 3 : 1 and 1 : 1 ratios respectively when similarly treated. The common breeding practice is to consider the parent homozygous when, if selfed or back-crossed, it fails to produce any recessive individuals in a reasonably large number of offspring.

Just what is to be considered an adequately large number of offspring has in the past been determined by the personal judgment of the individual investigator, and the difficulty of obtaining offspring in large numbers. There has been no general agreement based on mathematical considerations, probably because large numbers of offspring have not been found necessary in order to distinguish a homozygous dominant from a heterozygous parent producing such ratios as 3 : 1 and 1 : 1. The need of a statistical criterion of what is an adequately large number of offspring was realized when it became necessary in tetraploid races of the Jimson Weed (*Datura Stramonium*) to distinguish between matings which should produce only dominant purple offspring and those which should produce a 35 : 1 ratio of purples to whites. In distributions which are so asymmetrical as those given by sampling from the 35 : 1 ratio, we are hardly justified in using the ordinary theory of probable errors. Special tables have, therefore, been computed for use in work under way at the Station for Experimental Evolution. Since other investigators will probably meet with the need for similar criteria, it seems worth while to give tables showing the number of offspring

[1] *Jour. Hered.*, 8, 125–131, Fig. 10, 1917.

which should be considered in order to distinguish matings which should give all dominant individuals from those which may produce recessives.

The theory is of course quite simple. It is assumed that the expected ratio of dominant to recessive is known, and is $p : q$, where $p + q = 1$. The distribution of the chances of obtaining dominant and recessive individuals in the frequencies $n : 0$, $(n—1) : 1$, $(n—2) : 2$, etc., when n individuals are grown is $(p + q)^n$. To ascertain the probability of securing all dominant individuals in a culture which should show a definite ratio of dominant to recessive offspring we have merely to table p^n against n. If this value is very small, it is reasonable to assume that in practice a culture of n individuals all of the dominant type represents a parent or parents capable of producing only offspring of the dominant type. Thus, for example, if seeds which should produce dominant and recessive individuals in a $5 : 1$ ratio were sown, a culture of 35 all dominant individuals should be obtained only 17 times in 10,000. Hence, if a sowing is made to distinguish between a mating capable of producing only dominants and one which should give recessives in a $5 : 1$ ratio, and there results a culture of 35 individuals all of the dominant type, it is altogether reasonable to assume that the mating in question is incapable of producing recessives.

Tables have been formed to include the $3 : 1$ and $1 : 1$ ratios familiar in ordinary disomic inheritance, the $2 : 1$ and $8 : 1$ ratios found in trisomic inheritance in the mutant Poinsettia, and the $5 : 1$, $11 : 1$, and $35 : 1$ ratios found in tetraploids in *Datura*. Some of these ratios are suggested by published data on *Œnothera Lamarckiana* and *Primula sinensis,* and will probably be found ultimately by those studying other forms.

The tables enable one to decide how large a culture is necessary on a probability basis. If it is felt that only 1 chance in 1,000 of the mating being capable of producing a recessive is sufficient evidence that the culture represents only dominants, then, to distinguish a mating which can produce only dominants from one which should give a $1 : 1$ ratio, a culture of at least 10 individuals is necessary. If the $3 : 1$ ratio is the one in question, then 24 individuals are necessary; while if a $35 : 1$ ratio is considered, 244 individuals are required. In other words, cultures of 10, 24 and 244 individuals are of equal value in distinguishing matings which should produce only dominants from those which

should give, respectively, 1 : 1, 3 : 1, and 35 : 1 ratios of dominants to recessives.

A. F. Blakeslee,
John Belling,
J. Arthur Harris.

TABLE I

VALUES OF p^n FOR 1 : 1, 2 : 1, 3 : 1, AND 5 : 1 RATIOS

N	1 : 1	2 : 1	3 : 1	5 : 1	N	3 : 1	5 : 1
1....	.5000	.6667	.7500	.8333	19	.0042	.0313
2....	.2500	.4444	.5625	.6944	20	.0032	.0261
3....	.1250	.2963	.4219	.5787	21	.0024	.0217
4....	.0625	.1975	.3164	.4823	22	.0018	.0181
5....	.0313	.1317	.2373	.4019	23	.0013	.0151
6....	.0156	.0878	.1780	.3349	24	.0010	.0126
7....	.0078	.0585	.1335	.2791	25	—	.0105
8....	.0039	.0390	.1001	.2326	26	—	.0087
9....	.0020	.0260	.0751	.1938	27	—	.0073
10....	.0010	.0173	.0563	.1615	28	—	.0061
11....	—	.0116	.0422	.1346	29	—	.0051
12....	—	.0077	.0317	.1122	30	—	.0042
13....	—	.0051	.0238	.0935	31	—	.0035
14....	—	.0034	.0178	.0779	32	—	.0029
15....	—	.0023	.0134	.0649	33	—	.0024
16....	—	.0015	.0100	.0541	34	—	.0020
17....	—	.0010	.0075	.0451	35	—	.0017
18....	—	—	.0056	.0376	36	—	.0014

TABLE II

VALUES OF p^n FOR 8 : 1 RATIO

N	0	1	2	3	4	5	6	7	8	9
1......	.3079	.2737	.2433	.2163	.1922	.1709	.1519	.1350	.1200	.1067
2......	.0948	.0843	.0749	.0666	.0592	.0526	.0468	.0416	.0370	.0329
3......	.0292	.0260	.0231	.0205	.0182	.0162	.0144	.0128	.0114	.0101
4......	.0090	.0080	.0071	.0063	.0056	.0050	.0044	.0039	.0035	.0031
5......	.0028	.0025	.0022	.0019	.0017	.0015	.0014	.0012	.0011	.0010

TABLE III

VALUES OF p^n FOR 11 : 1 RATIO

N	0	1	2	3	4	5	6	7	8	9
1......	.4189	.3840	.3520	.3227	.2958	.2711	.2485	.2278	.2088	.1914
2......	.1755	.1609	.1475	.1352	.1239	.1136	.1041	.0954	.0875	.0802
3......	.0735	.0674	.0618	.0566	.0519	.0476	.0436	.0400	.0366	.0336
4......	.0308	.0282	.0259	.0237	.0217	.0199	.0183	.0167	.0154	.0141
5......	.0129	.0118	.0108	.0099	.0091	.0083	.0077	.0070	.0064	.0059
6......	.0054	.0050	.0045	.0042	.0038	.0035	.0032	.0029	.0027	.0025
7......	.0023	.0021	.0019	.0017	.0016	.0015	.0013	.0012	.0011	.0010

TABLE IV

VALUES OF pn FOR 35 : 1 RATIO

N	0	1	2	3	4	5	6	7	8	9
3.....	.4295	.4176	.4060	.3947	.3837	.3731	.3627	.3526	.3428	.3333
4.....	.3241	.3151	.3063	.2978	.2895	.2815	.2737	.2661	.2587	.2515
5.....	.2445	.2377	.2311	.2247	.2184	.2124	.2065	.2007	.1952	.1897
6.....	.1844	.1793	.1744	.1695	.1648	.1602	.1558	.1515	.1473	.1432
7.....	.1392	.1353	.1316	.1279	.1244	.1209	.1175	.1143	.1111	.1080
8.....	.1050	.1021	.0993	.0965	.0938	.0912	.0887	.0862	.0838	.0815
9.....	.0792	.0770	.0749	.0728	.0708	.0688	.0669	.0651	.0632	.0615
10.....	.0598	.0581	.0565	.0549	.0534	.0519	.0505	.0491	.0477	.0464
11.....	.0451	.0439	.0426	.0414	.0403	.0392	.0381	.0370	.0360	.0350
12.....	.0340	.0331	.0322	.0313	.0304	.0296	.0287	.0279	.0272	.0264
13.....	.0257	.0250	.0243	.0236	.0229	.0223	.0217	.0211	.0205	.0199
14.....	.0194	.0188	.0183	.0178	.0173	.0168	.0164	.0159	.0155	.0150
15.....	.0146	.0142	.0138	.0134	.0131	.0127	.0123	.0120	.0117	.0113
16.....	.0110	.0107	.0104	.0101	.0098	.0096	.0093	.0091	.0088	.0086
17.....	.0083	.0081	.0079	.0076	.0074	.0072	.0070	.0068	.0066	.0065
18.....	.0063	.0061	.0059	.0058	.0056	.0055	.0053	.0052	.0050	.0049
19.....	.0047	.0046	.0045	.0044	.0042	.0041	.0040	.0039	.0038	.0037
20.....	.0036	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0029	.0028
21.....	.0027	.0026	.0025	.0025	.0024	.0023	.0023	.0022	.0021	.0021
22.....	.0020	.0020	.0019	.0019	.0018	.0018	.0017	.0017	.0016	.0016
23.....	.0015	.0015	.0015	.0014	.0014	.0013	.0013	.0013	.0012	.0012
24.....	.0012	.0011	.0011	.0011	.0010	.0010	.0010	.0010	.0009	.0009

LINKAGE BETWEEN BRACHYSM AND ADHERENCE IN MAIZE

ADHERENCE first appeared in the second generation of a brachytic x Boone Co. White hybrid and seemed to be linked closely with normal stature.[1] Subsequent progenies indicated that there was no very close linkage between these characters and possibly none at all.[2] The relationship of these two interesting characters has been tested now in more detail and it seems certain that their genes are located on the same chromosome.

A cross was made between a non-adherent brachytic plant and an adherent plant of normal stature, both plants being segregates in the F_2 of the brachytic-Boone hybrid. The first generation segregated with respect to the brachytic culms, approximately half the plants being of normal stature, but none exhibited a tendency toward adherence. From the behavior of the F_1 plants it is apparent that the adherent parent of the cross was heterozygous with respect to the brachytic character.

[1] Kempton, J. H., "A Brachytic Variation in Maize," U. S. Dept. of Agri. *Bull.* 925, Feb., 1921.

[2] Kempton, J. H., "Heritable Characters in Maize V.   Adherence," *Journal of Heredity*, Vol. XI, No. 7, Sept.–Oct., 1920.